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Sachdeva et al.

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(54) **ORTHODONTIC DEVICE**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 11/996,090, filed as application No. PCT/JP2006/314064 on Jul. 14, 2006, now Pat. No. 8,272,867.

(30) **Foreign Application Priority Data**

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A61C 3/00 (2006.01)
A61C 7/28 (2006.01)

(52) **U.S. Cl.**
CPC ***A61C 7/285*** (2013.01)

(58) **Field of Classification Search**
USPC 433/8–16
See application file for complete search history.

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Primary Examiner — Heidi M Eide

(57) **ABSTRACT**

An orthodontic bracket having a slot formed by arm parts facing each other in the vertical direction, and an inner part, inserted into the slot, having a socket for holding a wire is disclosed. The shape of the socket is designed for applying desired forces to a tooth through the wire when the bracket is attached to the tooth. Forces can be changed simply by changing the inner part; replacing the bracket attached to the tooth. When the inner part is inserted into the slot, the inner part closes the slot and it is held in the position by the arm parts; enabling the wire to be securely held in its position.

23 Claims, 19 Drawing Sheets

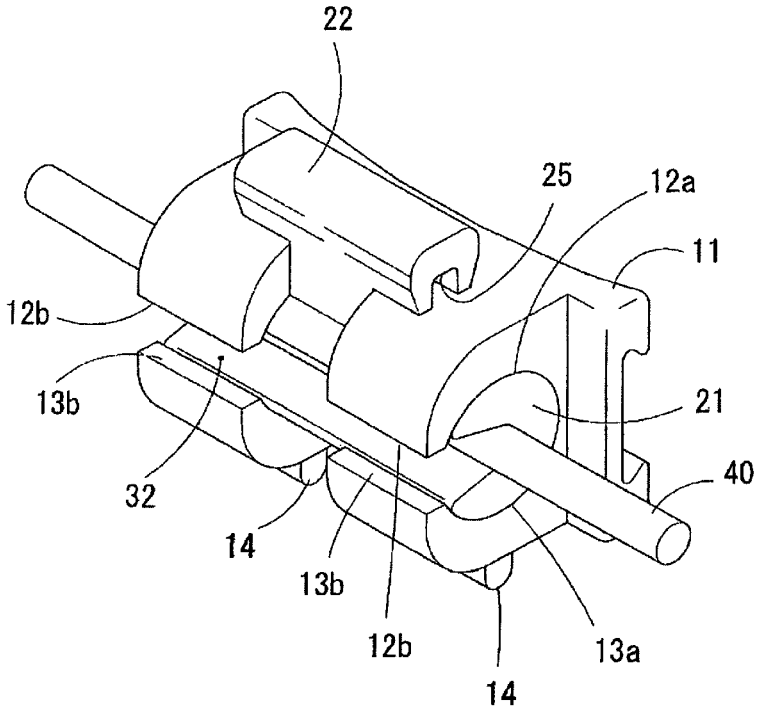


Fig. 1

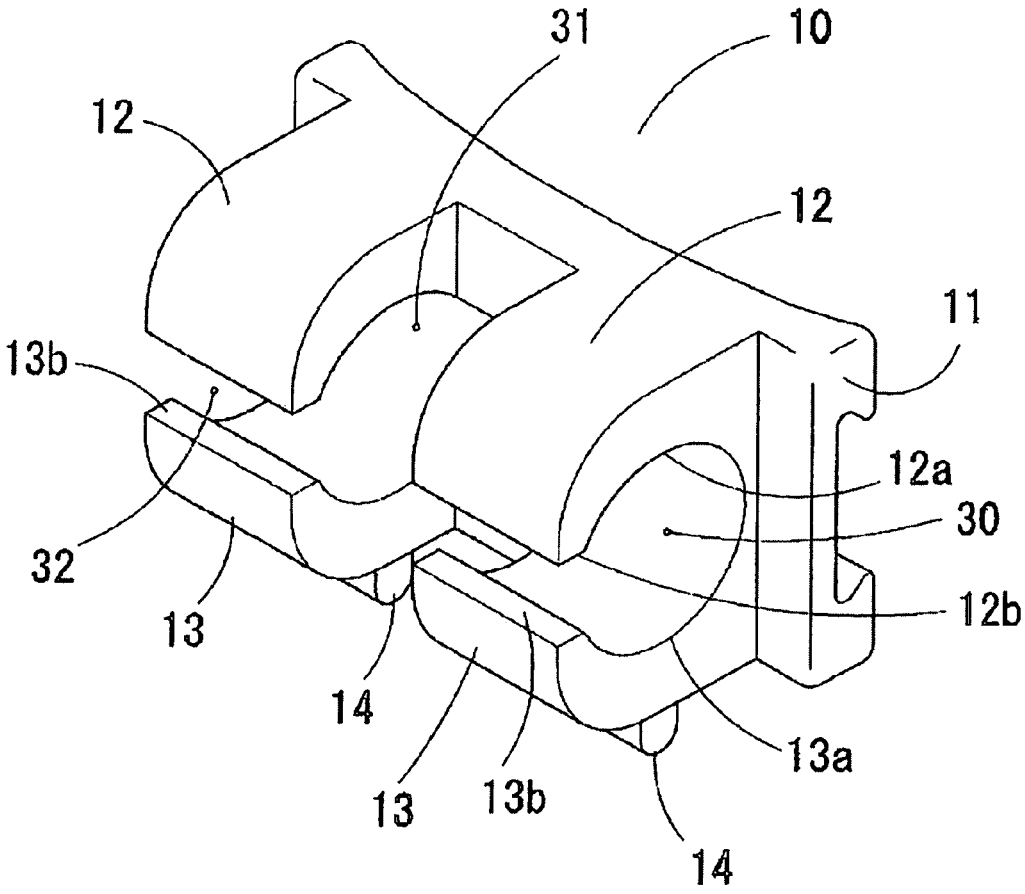
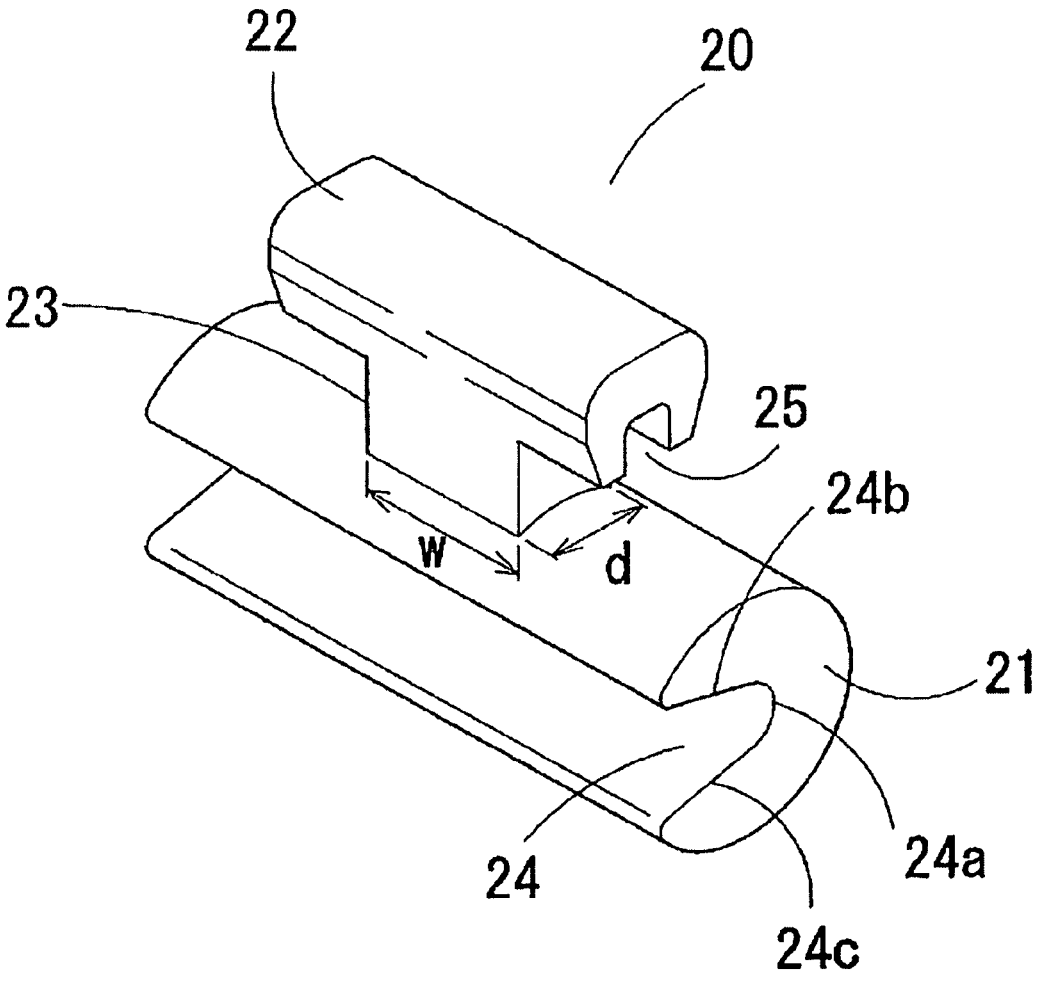


Fig. 2



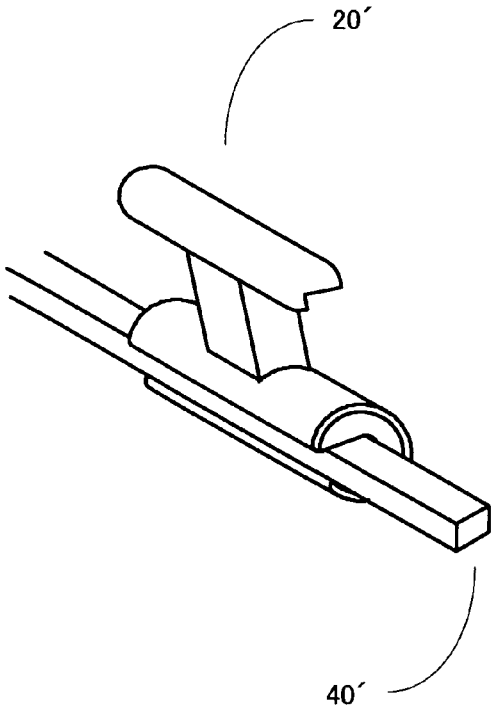


Fig. 2A

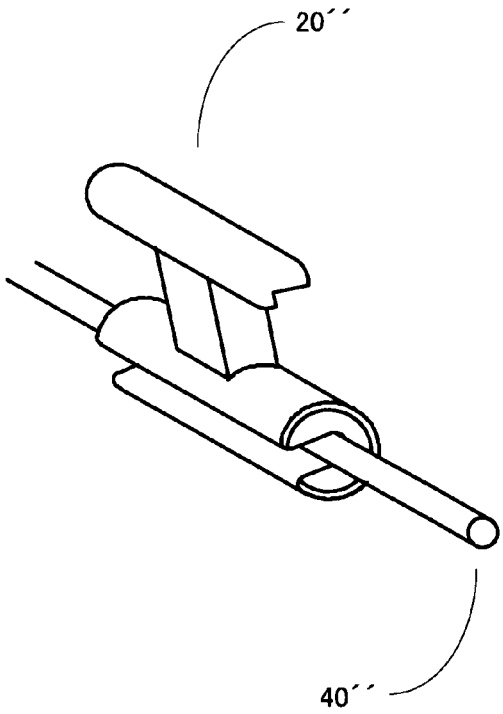


Fig. 2B

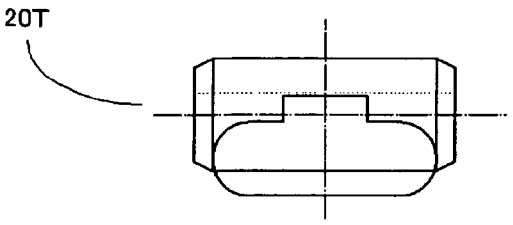


Fig. 2C1

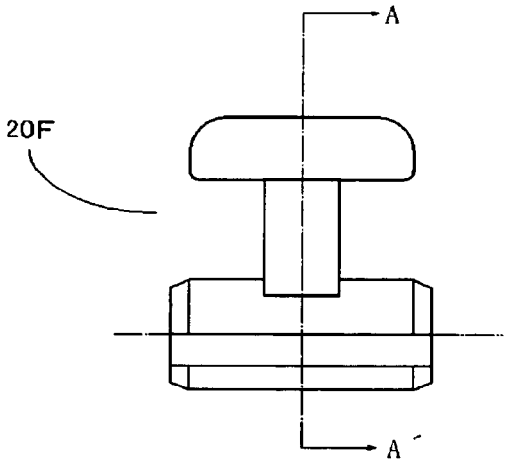


Fig. 2C2

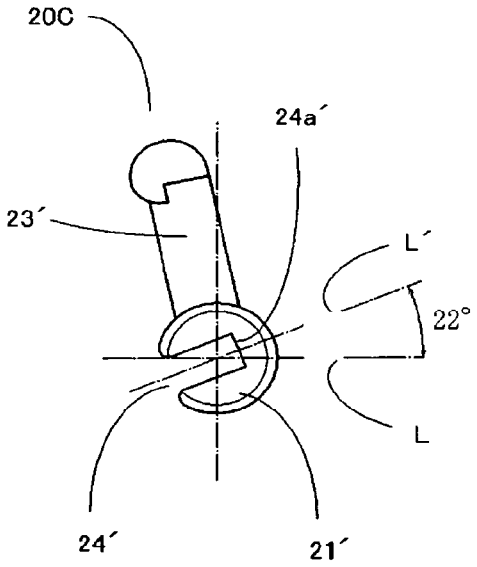


Fig. 2C3

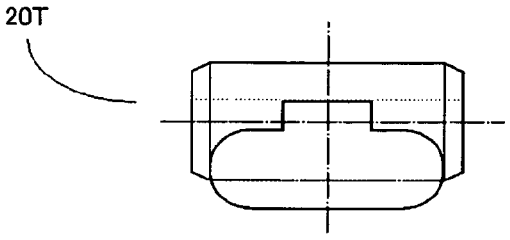


Fig. 2D1

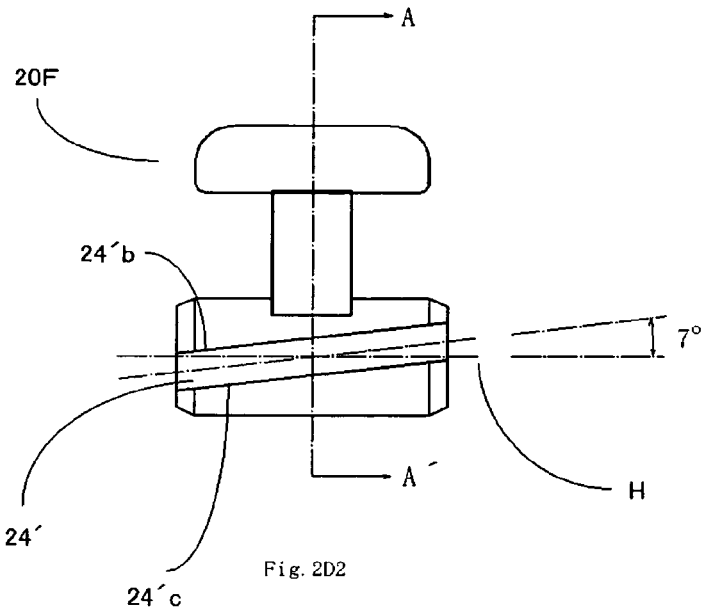


Fig. 2D2

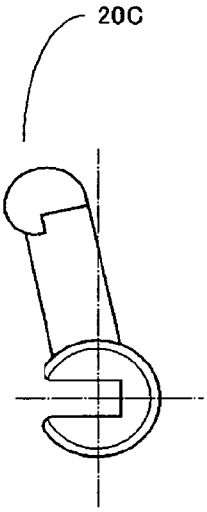


Fig. 2D3

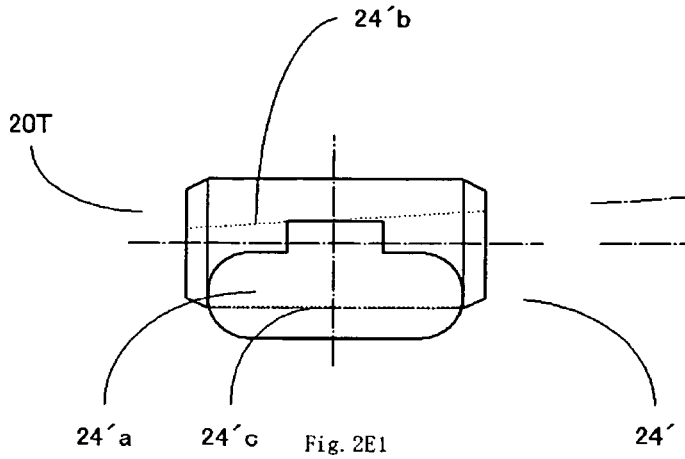


Fig. 2E1

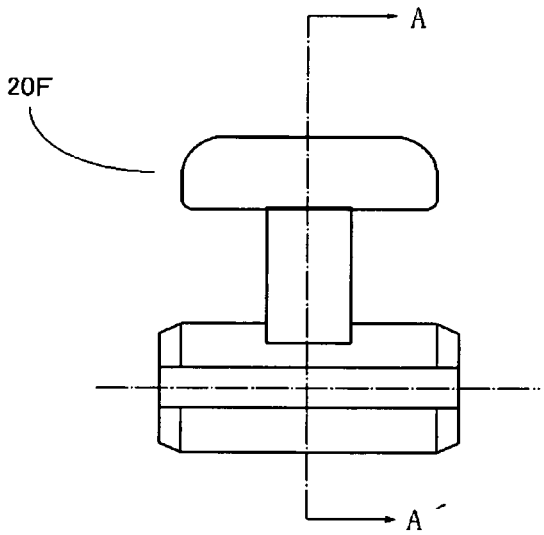


Fig. 2E2

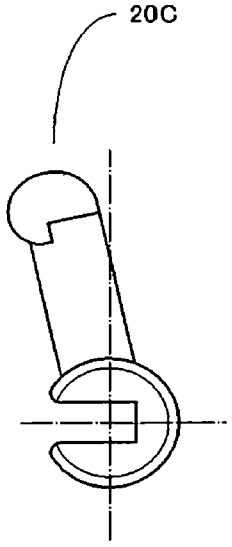


Fig. 2E3

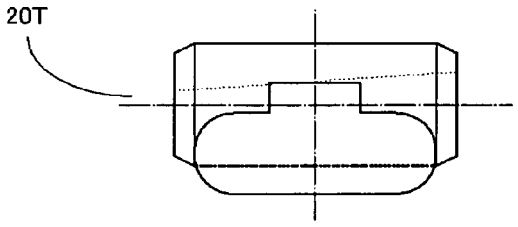


Fig. 2F1

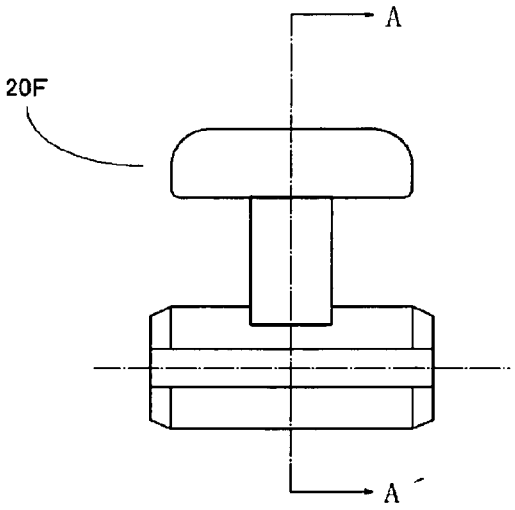


Fig. 2F2

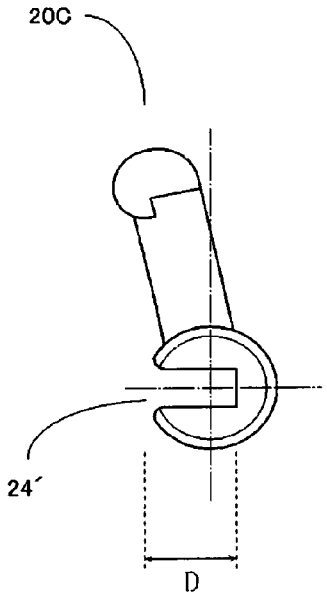


Fig. 2F3

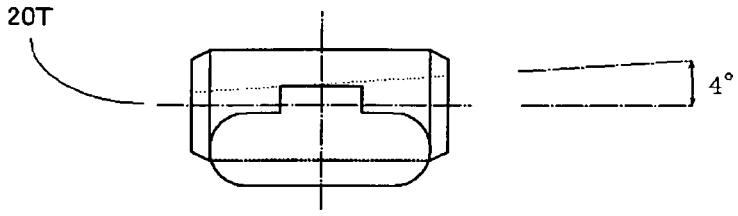


Fig. 2G1

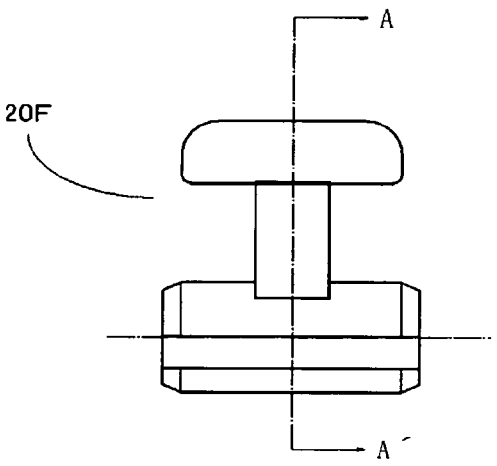


Fig. 2G2

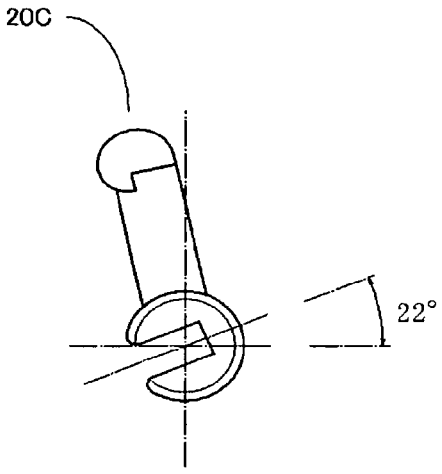


Fig. 2G3

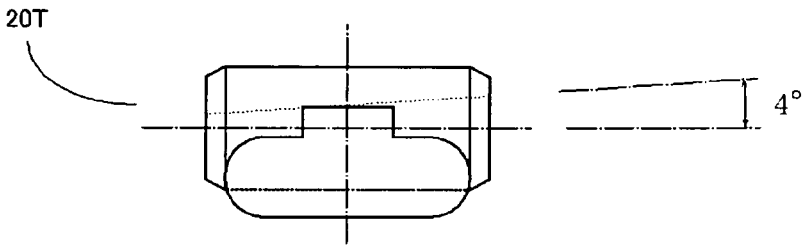


Fig. 2H1

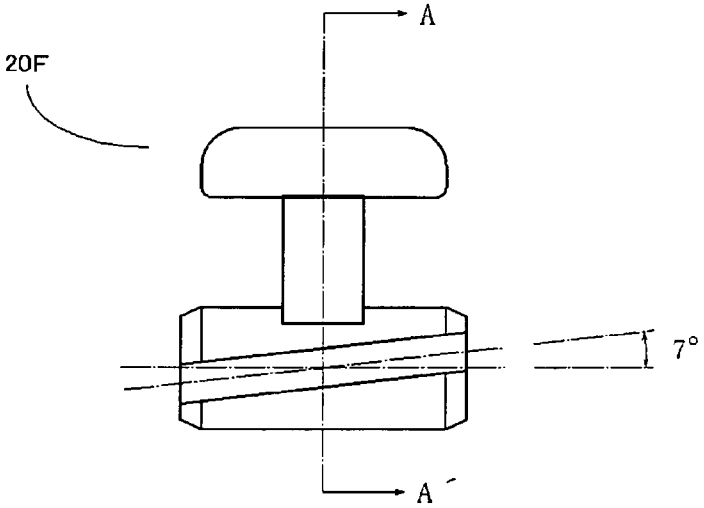


Fig. 2H2

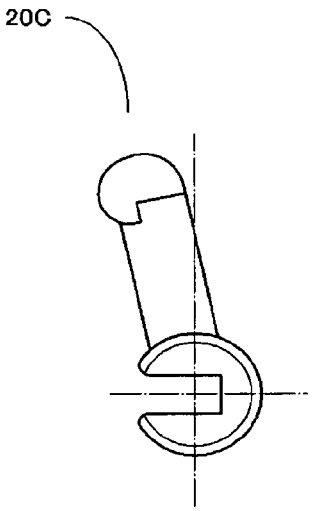


Fig. 2H3

Fig. 3

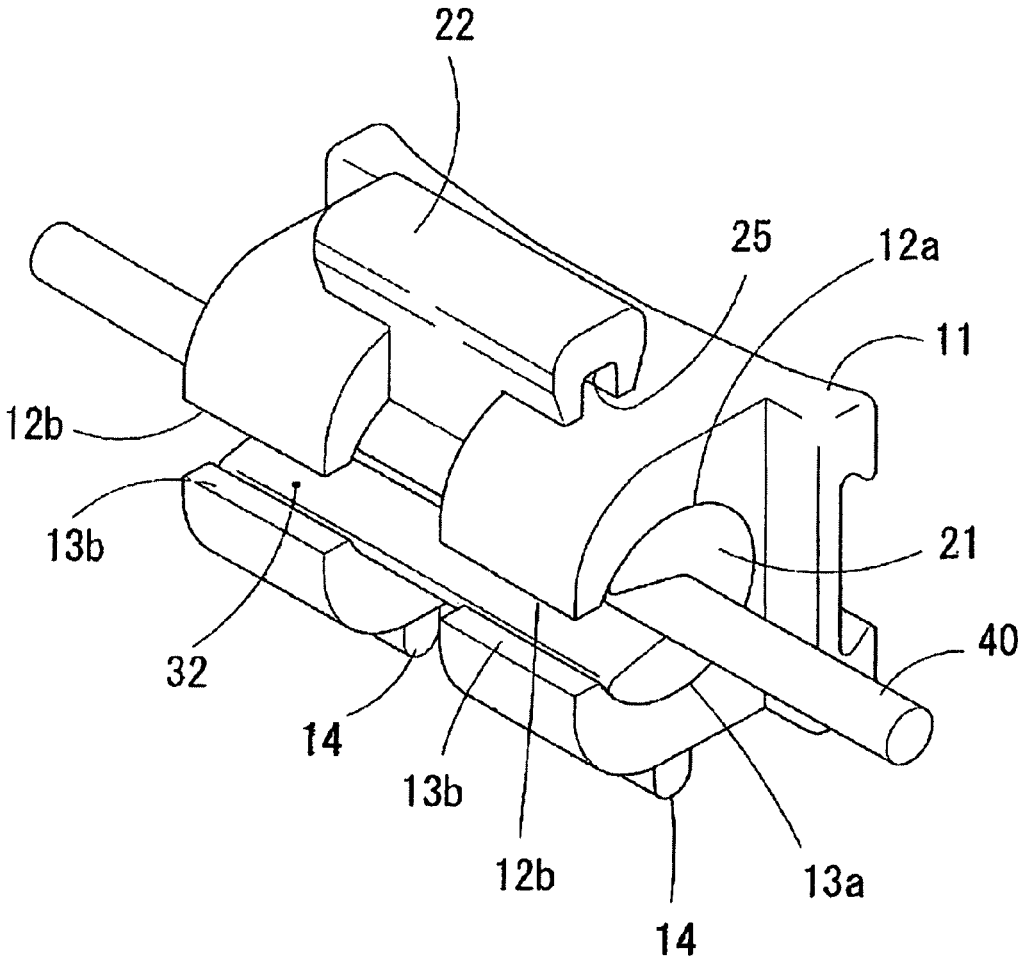


Fig. 4

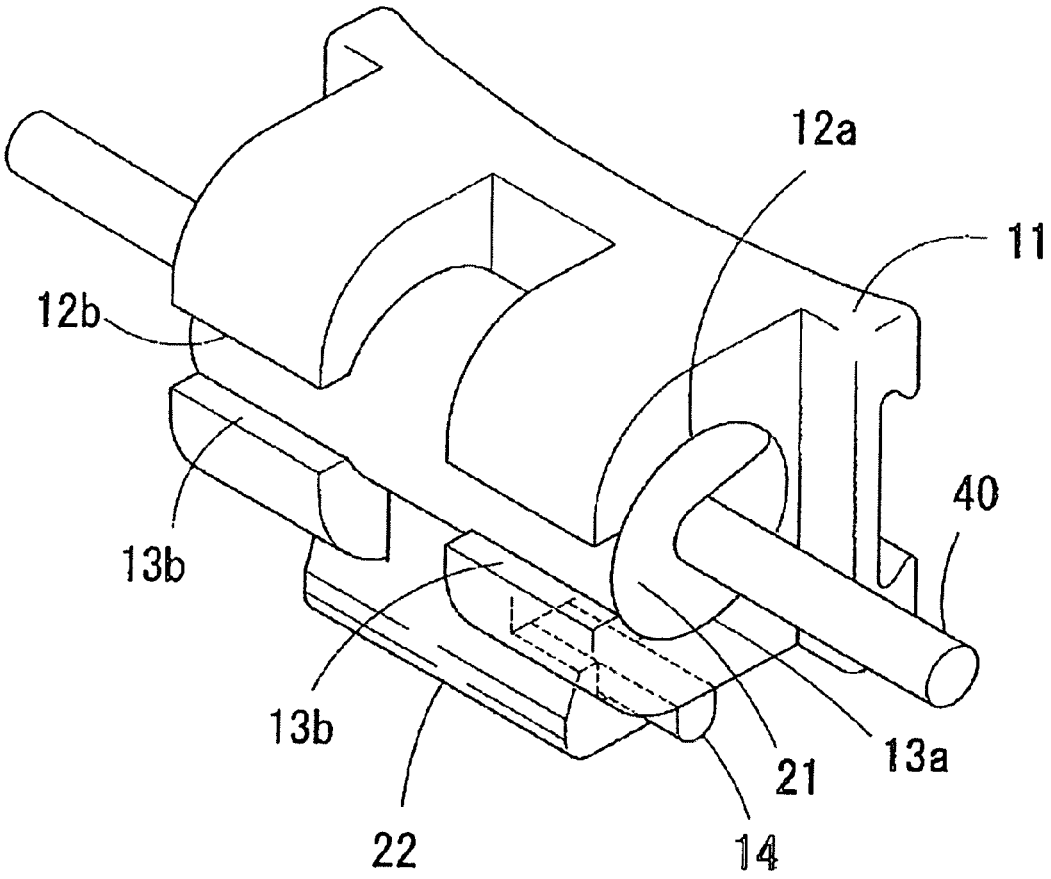


Fig. 5

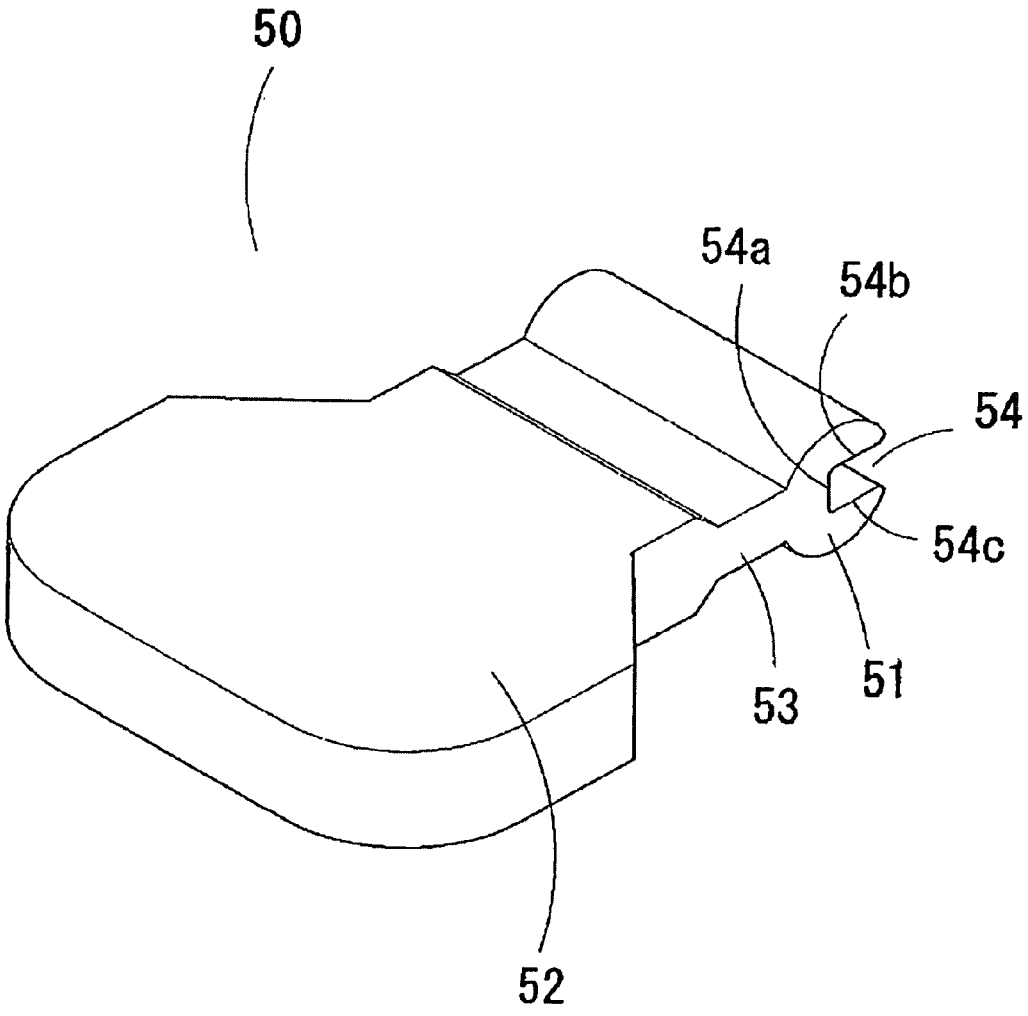


Fig. 6

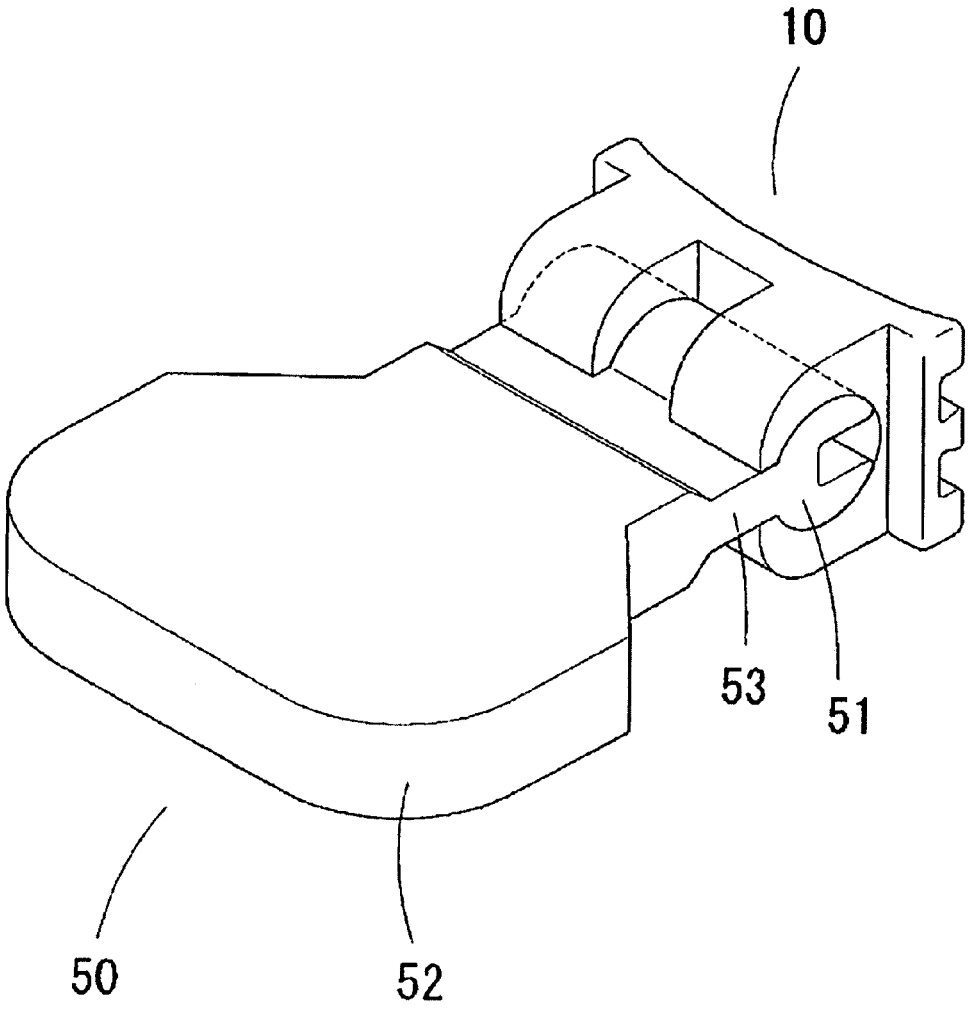


Fig. 7

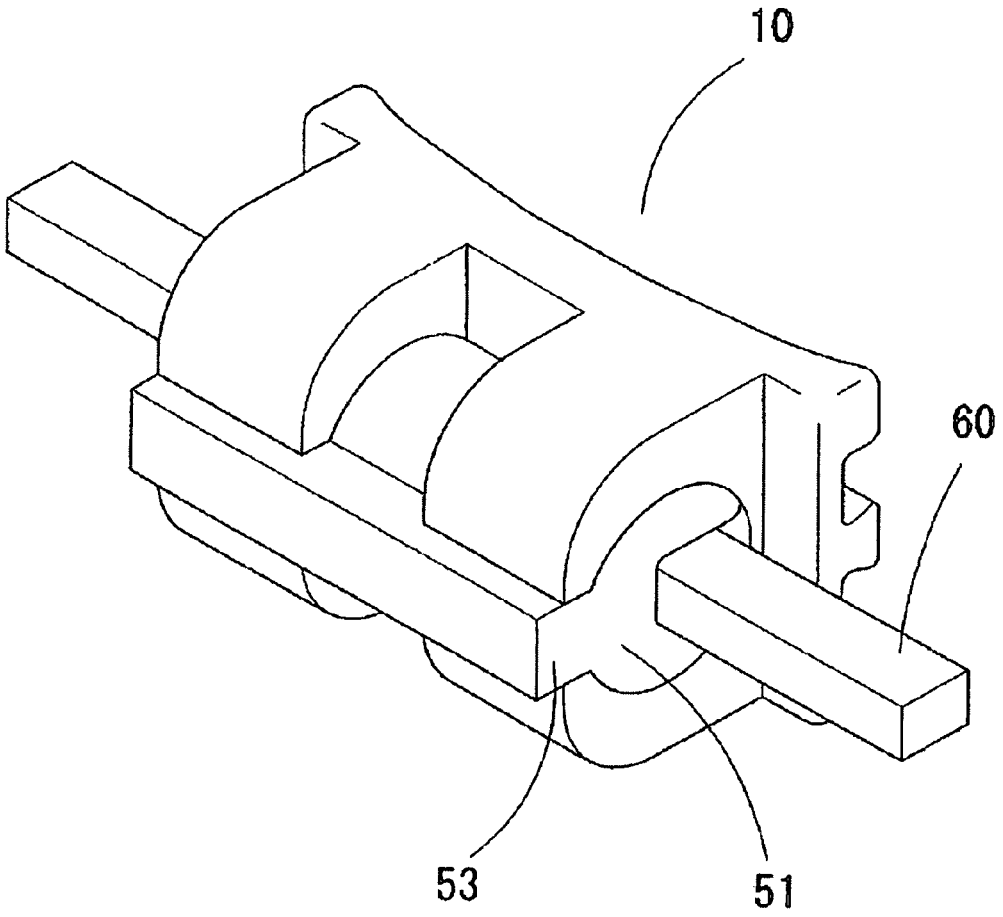


Fig. 8

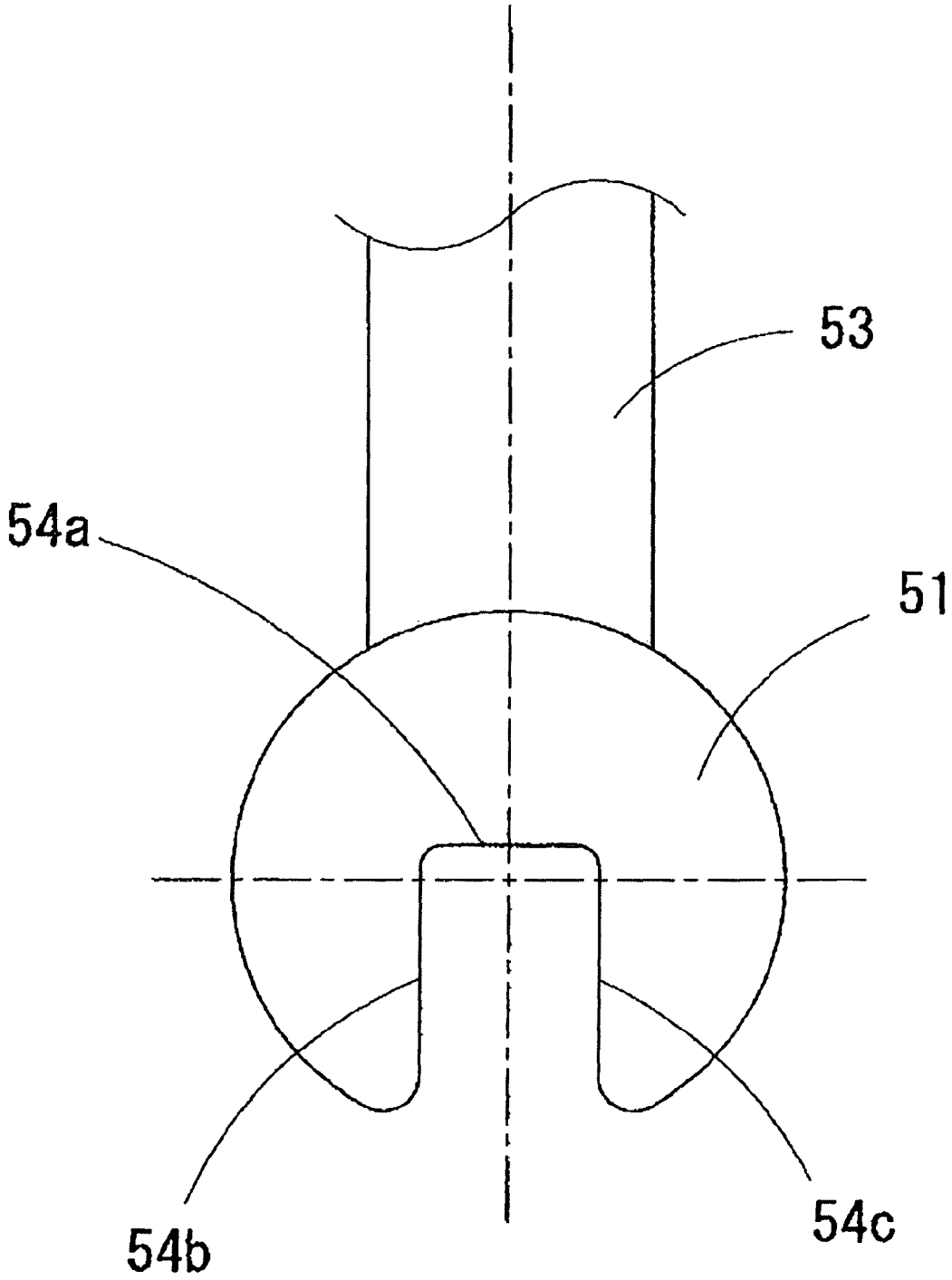


Fig. 9

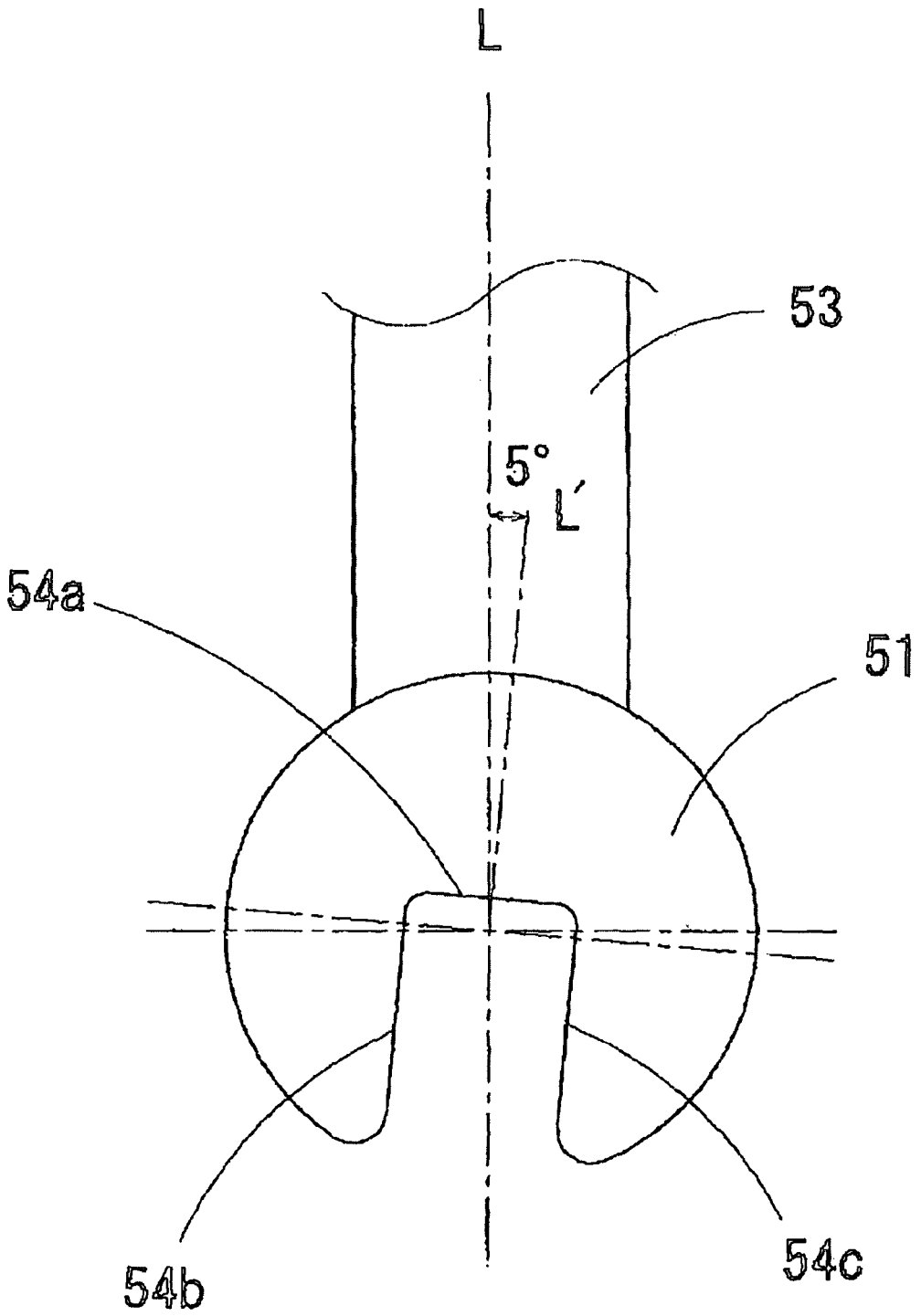


Fig. 10

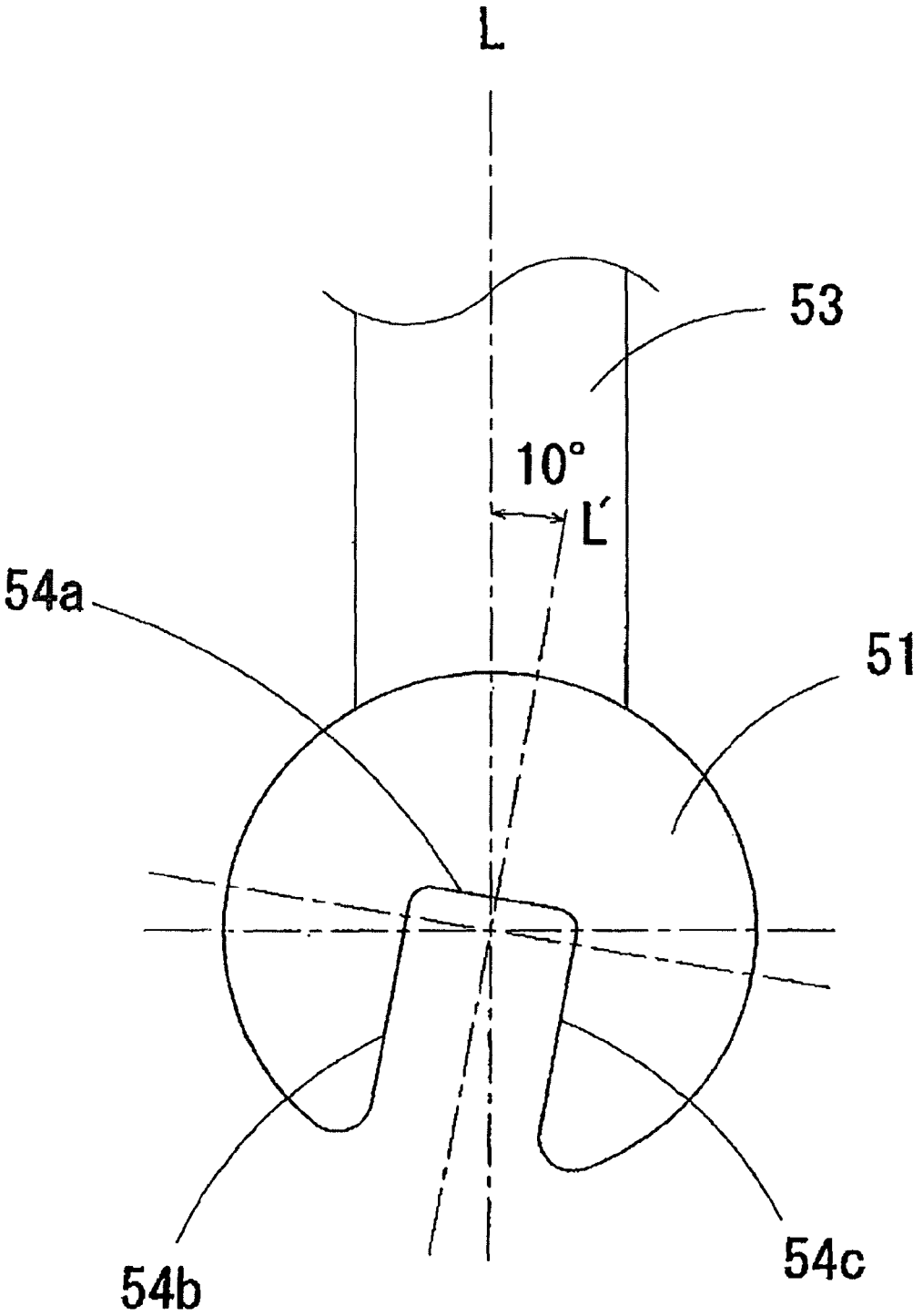


Fig. 11

Related Art

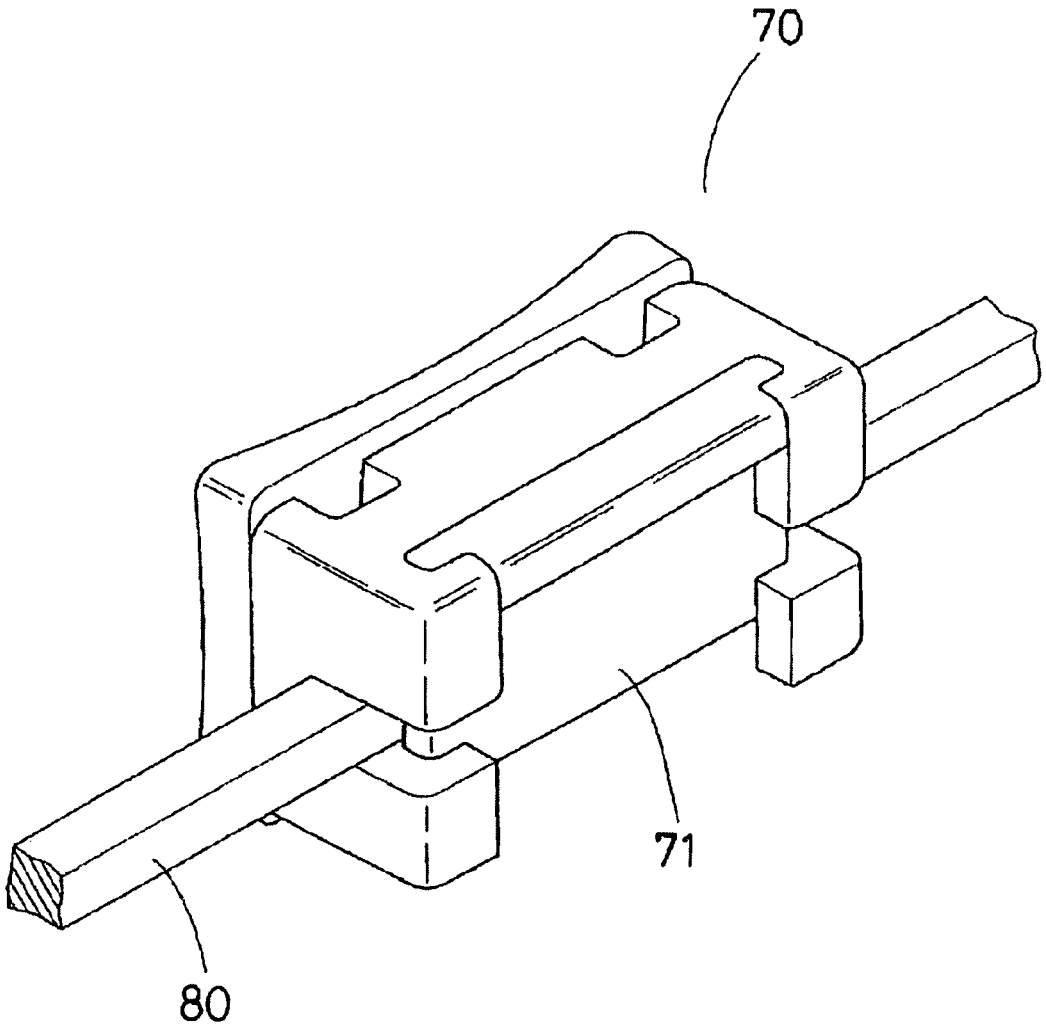
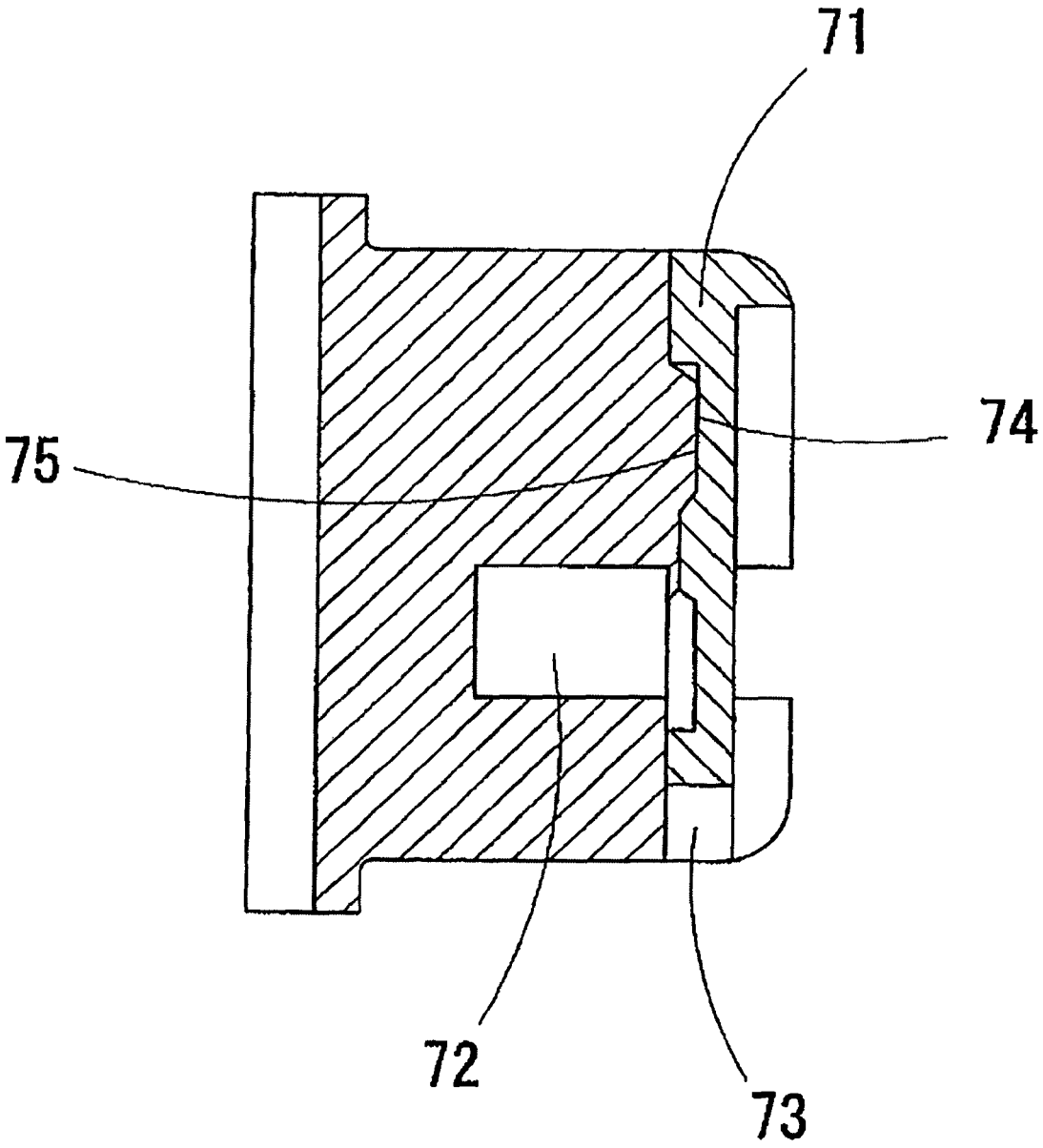


Fig. 12

Related Art



ORTHODONTIC DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part application of prior application Ser. No. 11/996,090, filed Jan. 18, 2008 now U.S. Pat. No. 8,272,867, which is a National Stage Entry of PCT/JP2006/314064, filed Jul. 14, 2006, whose Parent Application Number is 2005-209524, Country JP, filed Jul. 20, 2005; the entire contents of each of which are incorporated by reference herein.

BACKGROUND OF THE INVENTION

A. Field of the Invention

The present invention relates to an orthodontic device.

B. Description of Related Art

A conventional orthodontic device **70** includes a bracket having a horizontal groove **72** into which a wire **80** is inserted and a vertical groove **73** formed in the front part thereof and a thin-plate-like slide member **71** inserted in the vertical groove **73** (see FIGS. **11** and **12** and the Patent Document 1). The slide member **71** can move vertically along the vertical groove **73**, and the slide member **71** is moved downwardly to close the horizontal groove **72**, thereby holding the wire **80** therein.

Patent Document 1: Japanese Patent Publication No. 3512466 B.

However, the slide member **71** is a thin plate and therefore is inferior in strength. In addition, most of the front surface of the slide member **71** is exposed, and therefore, the slide member **71** is likely to be subjected to an external force and can be damaged when subjected to the external force.

In addition, the slide member **71** has a shallow recess **74** formed in the back surface thereof, the bracket has a short protrusion **75** formed on the front surface thereof, and the recess **74** and the protrusion **75** are lightly engaged with each other. Therefore, there is a possibility that the slide member **71** is disengaged from and comes off the bracket when the slide member **71** is subjected to an external force. If the slide member **71** comes off the bracket, the wire **80** cannot be held in the bracket.

To minimize the possibility of the slide member **71** coming off, a spring member can be used to keep the slide member **71** engaged with the bracket by the action of the resilient force. However, the spring member incorporated in the bracket extends along the depth, so that the structure is undesirably complicated (see FIG. **18** of the Patent Document 1).

SUMMARY OF THE INVENTION

An object of the present invention is to provide an orthodontic device which does not require replacing of brackets during orthodontic treatment of a patient; and is capable of holding a wire with a simple, not complicated, structure.

In order to attain the object, according to the present invention, there is provided an orthodontic device, including: a bracket having a slot defined by an upper arm portion and a lower arm portion facing each other; and an inner part having a socket for holding a wire, in which the inner part is inserted into the slot to be held between the upper arm portion and the lower arm portion, thereby closing an opening of the slot.

With such a configuration, the wire can be held with reliability with a simple structure in which the inner part having the socket is inserted into the slot formed in the bracket. Since the structure is simple, the orthodontic device is easy to handle in treatment and can be reduced in size. Furthermore, since the inner part is held between the upper and lower arm portions facing each other, the inner part is inserted stably, so that the opening of the slot is stably kept closed, and the wire can be held with reliability. Furthermore, since the inner part has a shape suitable for insertion into the slot defined by the upper and lower arm portions facing each other, the inner part has a sufficient strength.

In the orthodontic device according to the present invention, the socket of the inner is shaped to provide desired forces to the teeth in conjunction with an archwire. The socket of the inner part may be angled. More specifically, the orthodontic device may be characterized in that the direction of opening of the socket of the inner part is angled.

With such a configuration, different torque depending on the angle of the direction of opening of the socket can be applied to a tooth. When applying a torque, if a plurality of inner parts having differently angled sockets are prepared, a desired torque can be applied only by changing the inner part without changing the bracket, which is quite preferable. In addition, the treatment can be performed easily, and the treatment time can be reduced.

Angling the direction of opening of the socket means angling the perpendicular passing through the center of the socket with respect to the perpendicular passing through the center of the base part of the inner part.

Besides torque, the socket of the inner part may be shaped to provide other types of forces as well such as angulation, rotation, and translation; either individually or in some form of combination.

Furthermore, in the orthodontic device according to the present invention, the inner part may have a handle part.

The slot and the inner part are difficult to handle in treatment because of their small sizes. However, if the inner part is provided with the handle part, the inner part can be handled by holding the handle part. As a result, the inner part can be easily handled, and the treatment can be easily performed.

Thus, an orthodontic device capable of holding a wire with a simple, not complicated, structure is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a bracket according to embodiments 1 and 2 of the present invention;

FIG. **2** is a perspective view of an inner part according to the embodiment 1 of the present invention;

FIG. **2**A shows a perspective view of the inner part with the socket shaped to hold a rectangular wire.

FIG. **2**B shows a perspective view of the inner part with the socket shaped to hold a round wire.

FIGS. **2**C**1**-**2**H**3** show different shapes of the socket of the inner part for providing different forces during orthodontic treatments of patients. Each group of these, figures, **2**C**1**-**2**C**3**, **2**D**1**-**2**D**3**, **2**E**1**-**2**E**3**, **2**F**1**-**2**F**3**, **2**G**1**-**2**G**3**, and **2**H**1**-**2**H**3**, shows three views of the inner part, namely, front view, top view and cross-sectional view of the inner part.

FIGS. **2**C**1**-**2**C**3** show the socket shaped to provide torque.

FIGS. **2**D**1**-**2**D**3** show the socket shaped to provide angulation.

FIGS. **2**E**1**-**2**E**3** show the socket shaped to provide rotation.

FIGS. **2**F**1**-**2**F**3** show the socket shaped to provide translation.

FIGS. **2**G**1**-**2**G**3** show the socket shaped to provide torque and rotation.

FIGS. **2**H**1**-**2**H**3** show the socket shaped to provide angulation and rotation.

FIG. **3** is a perspective view of the inner part inserted in the bracket in the embodiment 1 of the present invention;

FIG. **4** is a perspective view of the inner part inserted in the bracket in the embodiment 1 of the present invention;

FIG. **5** is a perspective view of an inner part according to the embodiment 2 of the present invention;

FIG. **6** is a perspective view of the inner part inserted in the bracket in the embodiment 2 of the present invention;

FIG. **7** is a perspective view of the inner part shown in FIG. **6** from which a base part thereof has been cut away in the embodiment 2 of the present invention;

FIG. **8** is a perspective view of the inner part (the angle of opening equals to 0 degrees) according to the embodiment 2 of the present invention;

FIG. **9** is a perspective view of the inner part (the angle of opening equals to 5 degrees) according to the embodiment 2 of the present invention;

FIG. **10** is a perspective view of the inner part (the angle of opening equals to 10 degrees) according to the embodiment 2 of the present invention;

FIG. **11** is a perspective view of an example of the related art; and

FIG. **12** is a cross-sectional view of the example of the related art shown in FIG. **11**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following, best modes for carrying out the present invention will be described with reference to the drawings showing embodiments of the present invention. FIGS. **1** to **10** show orthodontic devices according to embodiments of the present invention.

Embodiment 1

FIGS. **1** to **4** show an embodiment 1.

An orthodontic device according to the embodiment 1 includes a bracket **10** and an inner part **20** inserted in the bracket **10**.

Referring to FIG. **1**, the bracket **10** has a base portion **11** that is to be attached to the tooth surface, an upper arm portion **12** extending forward from a front surface of the base portion **11**, and a lower arm portion **13** extending forward from the front surface of the base portion **11**.

The base portion **11** is intended to be attached to the tooth surface with an adhesive or the like and has a protrusion, which aids in attachment of the bracket **10** to the tooth surface, on the back surface thereof.

The upper arm portion **12** and the lower arm portion **13** form a slot **30**, in which the inner part **20** is inserted. Specifically, an arc-shaped surface **12***a* of the upper arm portion **12** and an arc-shaped surface **13***a* of the lower arm portion facing each other form the slot **30**, which is a space having a substantially cylindrical shape.

The upper arm portion **12** has the shape of a hook, and the tip part of the upper arm portion **12** is curved to cover the outer perimeter of the inner part **20**, as shown in FIG. **3**. Similarly, the lower arm portion **13** has the shape of a hook, and the tip part of the lower arm portion **13** is curved to cover the outer perimeter of the inner part **20**. Specifically, most of the lower surface of the upper arm portion **12** is constituted by the semicircular arc-shaped surface **12***a*, most of the upper surface of the lower arm portion **13** is constituted by the semicircular arc-shaped surface **13***a*, and the two surfaces facing each other define the substantially cylindrical slot **30**. When the inner part **20** is inserted in the slot **30**, the inner part **20** is held between the arc-shaped surface **12***a* of the upper arm portion **12** and the arc-shaped surface **13***a* of the lower arm portion **13**. The horizontal width of the slot **30** and the horizontal width of the inner part **20** are substantially equal to each other.

The slot **30** thus configured stably holds the inner part **20**, and therefore, the possibility of the inner part **20** coming off the bracket **10** is reduced compared with the example of the related art described earlier. In addition, the front surface of the inner part **20** is less exposed compared with the example of the related art described earlier, and therefore, the inner part **20** is less affected by external forces and less susceptible to damage.

The upper arm portion **12** has a flat surface **12***b* at the tip end thereof The lower arm portion **13** also has a flat surface **13***b* at the tip end thereof. The flat surface **12***b* of the upper arm portion **12** and the flat surface **13***b* of the lower arm portion **13** face each other and define an opening **32** of the slot **30**. The opening **32** is a space that allows horizontal movement of a joint part **23** of the inner part **20**. In addition, the opening **32** helps to insert a wire **40** into the slot **30**. The vertical width of the opening **32** is substantially equal to the thickness (d) of the joint part **23**.

The upper arm portion **12** and the lower arm portion **13** have a vertical slit **31** formed at the horizontal center thereof Specifically, the upper arm portion **12** and the lower arm portion **13** have the vertical slit **31**, which is a vertical notch formed to divide each of the arm portions in two. The vertical slit **31** is a space that allows vertical movement of the joint part **23** of the inner part **20**. The horizontal width of the vertical slit **31** is substantially equal to the horizontal width (W) of the joint part **23**.

Referring to FIG. **2**, the inner part **20** to be inserted into the slot **30** has a base part **21**, a handle part **22**, and the joint part **23** that couples the base part **21** and the handle part **22** to each other.

The base part **21**, which is to be inserted into the slot **30**, is shaped to conform to the shape of the slot **30**. That is, the base part **21** is shaped so that the base part **21** can be fitted into the slot **30**. In this embodiment, the slot **30** has a substantially cylindrical shape, and therefore, the base part **21** of the inner part **20** has a substantially cylindrical shape with a notch formed therein. The inner part **20** having such a shape has a higher section modulus and a higher strength than the thin-plate-like slide member of the example of the related art described earlier. Therefore, the inner part **20** is less susceptible to damage even if an external force is applied thereto.

The base part **21** has a socket **24** for holding the wire. The socket **24** is shaped considering the cross-section of the wire and desired forces to be applied to the wire during the orthodontic treatment of a patient. If during the treatment different forces are required to be applied to the wire than the current forces, then the inner part can be replaced with a new one having the socket designed to provide the proper forces; thereby avoiding the need to change the bracket bonded to the tooth of a patient. The shape of the socket **24** can be circular, square, rectangular, or any other desired shape depending upon the archwire used.

The base part **21** as shown in FIG. **2** has the socket **24** for holding the wire **40** having a circular cross section. The socket **24** is formed by cutting a part of the base part **21** to form a space for housing the wire **40** in the base part **21**. In this embodiment, the base part **21** having the socket **24** has a substantially C-shaped cross section and has an outward opening. Specifically, the socket **24** is defined by a bottom part **24***a* and side surfaces **24***b* and **24***c*, the bottom part **24***a* is an arc-shaped surface, and the side surfaces **24***b* and **24***c* are flat surfaces. The side surfaces **24***b* and **24***c* are inclined and diverge outwardly to form the opening. The wire **40** is

inserted into the opening. Alternate example configurations for the slot for holding different shapes of wires are shown in FIGS. **2**A and **2**B. FIG. **2**A shows a perspective view of the inner part **20'** with the socket shaped to hold a rectangular wire **40'**. In this case the bottom part and the side surfaces of the socket are all flat surfaces.

Similarly, FIG. **2**B shows a perspective view of the inner part **20"**with the socket shaped to hold a round wire **40"**. In this case the bottom part of the socket has a semi-circular surface and the side surfaces of the socket are flat surfaces.

The handle part **22** is coupled to the base part **21**. Specifically, the joint part **23** is connected to the outer perimeter of the base part **21** at one end and to the handle part **22** at the other end. The handle part **22** has a recess **25** formed therein. The recess **25** opens toward the joint part **23** and is engaged with a protrusion **14** formed on the back surface of the lower arm portion **13** when the handle part **22** is rotated downwardly.

The bracket **10** and the inner part **20** are each configured as described above. The two components are assembled as described below.

The inner part **20** and the slot **30** are placed side by side so that the arc-shaped outer perimeter of the inner part **20** and the arc-shaped surfaces **12***a* and **13***a* of the slot **30** are aligned with each other, and the opening **32** of the slot **30** and the joint part **23** are aligned each other. Then, the inner part **20** is moved horizontally and inserted into the slot **30**. When the joint part **23** enters the vertical slit **31**, the horizontal movement of the inner part **20** is stopped, and the inner part **20** is rotated by vertically moving the handle part **22**. Then, as shown in FIG. **3**, the opening **32** and the opening of the socket **24** of the inner part **20** are substantially aligned with each other. In this state, when the wire **40** is inserted into the opening **32**, the wire **40** reaches to the bottom part **24***a* of the socket **24** because the opening **32** and the opening of the socket **24** are aligned with each other.

Once the wire **40** is inserted into the socket **24**, the handle part **22** is moved downwardly to rotate the inner part **20** again. As the inner part **20** rotates, the opening of the socket **24** moves away from the opening **32** of the slot **30**, and the two openings become displaced from each other. Thus, as shown in FIG. **4**, the opening **32** is closed with a part of the inner part **20** other than the socket **24** (the part opposite to the socket **24**). In this way, the wire **40** is held in the bracket **10**.

Referring to FIG. **4** again, at this time, the recess **25** in the handle part **22** is engaged with the protrusion **14** on the lower arm portion **13** to help keep the wire **40** held in the inner part **20**. Since the joint part **23** is positioned in the vertical slit **31**, the inner part **20** is prevented from moving horizontally. In this way, the wire **40** is held with higher reliability. The same description also applies when the wire is square or rectangular or any other shape.

In the above description, the wire **40** is inserted after the inner part **20** is fitted into the bracket **10**. Alternatively, of course, the wire **40** can be inserted before the inner part **20** is inserted into the bracket **10**. The same description also applies when the wire is square or rectangular or any other shape.

FIGS. **2**C**1**-**2**H**3** show different shapes of the socket of the inner part for providing different forces during orthodontic treatments of patients. Each group of these figures, **2**C**1**-**2**C**3**, **2**D**1**-**2**D**3**, **2**E**1**-**2**E**3**, **2**F**1**-**2**F**3**, **2**G**1**-**2**G**3**, and **2**H**1**-**2**H**3**, shows three views of the inner part, namely, front view **20**F, top view **20**T, and cross-sectional view **20**C. The cross-sectional view **20**C is taken at the cross sectional plane formed by A-A' cutting the front view **20**F.

FIG. **2**C**1** shows the top view **20**T, FIG. **2**C**2** shows the front view **20**F, and FIG. **2**C**3** shows the cross-sectional view **20**C of the socket shaped to provide 22 degrees torque as shown in FIG. **2**C**3**. As further shown in FIG. **2**C**3**, the angle of opening of the socket **24'** is selected depending on the desired torque. The angle of inclination of the axis line L' with respect to the axis line L determines the torque, which is 22 degrees in FIG. **2**C**3**. Axis line L' passes through the center of the bottom surface **24***a'* and is perpendicular to the bottom surface **24***a'*. The axis line L passes through the center of the base part **21'** and along the centerline of the joint part **23'**. With such a configuration, different torque depending on the angle of opening of the socket **24'** can be applied. When applying a torque to a tooth surface, if inner parts having differently angled sockets are prepared, a desired torque can be applied only by selecting the appropriate inner part without changing the bracket. Therefore, the wire can be attached in a relatively short time, and the treatment time can be reduced.

FIGS. **2**D**1**, **2**D**2** and **2**D**3** show the top view **20**T, the front view **20**F and the cross-sectional view **20**C, respectively, of the socket shaped to provide 7 degrees angulation as shown in FIG. **2**D**2**. As further shown in FIG. **2**D**2**, the angulation is determined by the inclination angle between the top surface **24'***b* of the slot **24'** and the horizontal surface H, which is 7 degrees. The top surface **24'***b* and **24'***c* remain parallel.

FIGS. **2**E**1**, **2**E**2** and **2**E**3** show the top view **20**T, the front view **20**F and the cross-sectional view **20**C, respectively, of the socket shaped to provide 4 degrees rotation as shown in FIG. **2**E**1**. As further shown in FIG. **2**E**1**, in order to provide the rotation, the width of the bottom surface **24'***a* at one end is made greater than at the other end. The rotation is determined by the inclination angle between the top surface **24'***b* of the slot **24'** and the horizontal surface H, which is 4 degrees. The top surfaces **24'***b* and **24'***c* do not remain parallel in this case.

FIGS. **2**F**1**, **2**F**2** and **2**F**3** show the top view **20**T, the front view **20**F and the cross-sectional view **20**C, respectively, of the socket shaped to provide translation. As further shown in FIG. **2**F**3**, in order to provide translation, either the position of the socket **24'** with respect to the slot **30** is adjusted by positioning it up or down, or the depth D of the socket **24'** is increased or decreased. Increasing the depth D of the socket **24'** will bring the bottom surface of the socket **24'** closer to the inner surface of the slot **30**, shown in FIG. **1**; and decreasing the depth D of the socket **24'** will move the bottom surface of the socket **24'** away from the inner surface of the slot **30**.

FIGS. **2**G**1**, **2**G**2** and **2**G**3** show the top view **20**T, the front view **20**F and the cross-sectional view **20**C, respectively, of the socket shaped to provide combination of 22 degrees torque (FIG. **2**G**3**) and 4 degrees rotation (FIG. **2**G**1**).

This is achieved by combining the process described above with respect to FIG. **2**C**3** with the process described above with respect to FIG. **2**E**1**.

FIGS. **2**H**1**, **2**H**2** and **2**H**3** show the top view **20**T, the front view **20**F and the cross-sectional view **20**C, respectively, of the socket shaped to provide combination of 7 degrees angulation and 4 degrees of rotation. This is achieved by combining the process described above with respect to FIG. **2**D**2** with the, process describe above with respect to FIG. **2**E**1**.

Although other combinations of forces are not described above, one skilled in the art would be able to do so.

The bracket **10** is made of a dental metal, a synthetic material, a ceramic or a synthetic resin, for example, or any other suitable material. Similarly, the inner part **20** is made of a dental metal, a synthetic material, a ceramic or a synthetic resin, for example, or any other suitable material. The bracket **10** and the inner part **20** both may be made of the same material or of different materials. Examples of the synthetic resin include polymethyl methacrylate, polyoxymethylene, polycarbonate, polypropylene, polyethylene and polyethyl-

ene naphthalate. Many conventional orthodontic devices use metals for strength reasons. However, the orthodontic device according to the present invention has a simple structure and therefore can be reduced in size while maintaining a sufficient strength, so that the orthodontic device need not be made of a metal and can be made of a plastic or ceramic. Furthermore, since the orthodontic device has a simple structure and therefore can be reduced in size as described above, the orthodontic device is inconspicuous when attached to the teeth surface and is aesthetically pleasing. Thus, the orthodontic device puts reduced psychological and physical burdens on patients and therefore is preferable.

The bracket **10** has a width of about 2.8 to 3.5 mm, a height of about 2.5 mm and a depth of about 2.0 mm. The base portion **11** has a thickness of 0.45 mm, and the upper (lower) arm portion has a thickness (in the vertical direction) of about 0.1 mm at the base end thereof and a thickness (in the vertical direction) of about 0.25 mm at the tip end thereof. The vertical slit has a horizontal width of about 0.8 mm, and the opening **32** of the slot **30** has a vertical width of 0.7 mm. The cylindrical slot **30** has a diameter of about 1.3 mm and has a horizontal length of about 2.5 to 3.2 mm. The substantially cylindrical base part **21** of the inner part **20** has a diameter of about 1.3 mm, and the joint part has a thickness (d) of about 0.7 mm and a horizontal width (W) of about 0.8 mm. The depth of the groove of the socket is about 0.9 mm. The wire **40** has a diameter of about 0.012 to 0.020 inch.

The bracket **10** and the inner part **20** may be customized for a patient or may be selected from commercially available such products.

In summary, with the invention disclosed herein, once a bracket is bonded to a tooth of a patient, it does not have to be removed during the entire orthodontic treatment of the patient. Desired forces, such as torque, angulation, rotation or translation, or any combination of such forces can be achieved through the inner part. Inner part can be replaced with another one at any time during the orthodontic treatment. Bracket replacement can be eliminated. This would help the orthodontic treatment of a patient a great deal—it will be more comfortable, quicker and less expensive.

In case the wire design prevents rotation of the inner part, thereby preventing closure of the bracket slot opening, then the inner part can still be used only for treatment purposes where the inner part is replaced as dictated by the treatment without having to replace the bracket bonded to the tooth. As for holding the wire in its position under such conditions, some other mechanics can be used along with the inner part for the treatment.

Embodiment 2

FIGS. **1** and **5** to **10** show an embodiment 2 of the present invention.

An orthodontic device according to the embodiment 2 includes a bracket **10** and an inner part **50**. The bracket **10** in the embodiment 2 has the same structure as in the embodiment 1, but the inner part **50** has different structure.

As shown in FIG. **5**, the inner part **50** has a base part **51**, a handle part **52** and a joint part **53**. The base part **51** is to be inserted into a slot **30** and therefore shaped to conform to the shape of the slot **30**. In this embodiment, the slot **30** has a substantially cylindrical shape, and therefore, the base part **51** also has a substantially cylindrical shape with a notch formed therein. The notch formed in the base part **51** constitutes a socket **54** for holding a wire **60** having a rectangular cross section. The socket **54** is shaped to conform to the rectangular shape of the wire **60**. Specifically, referring to FIG. **8** and the like, the socket **54** is defined by opposite side surfaces **54***b* and **54***c* and a bottom surface **54***a* perpendicular to the side surfaces **54***b* and **54***c*. In the embodiment 2, the cross section of the wire can be any polygon and is not limited to the shape described in this embodiment and shown in the drawings.

Here again, the direction (angle) of opening of the socket **54** is appropriately selected. The angle of opening of the socket **54** is selected depending on a desired torque or rotation. For example, as shown in FIGS. **8** to **10**, the angle of inclination of an axis line L', which passes through the center of the bottom surface **54***a* perpendicular to the bottom surface **54***a*, with respect to an axis line L, which passes through the center of the base part **51** (center of the circle) and along the centerline of the joint part **53**, is selected to be 0 degrees, 5 degrees or 10 degrees, for example. With such a configuration, different torque depending on the angle of opening of the socket **54** can be applied. When applying a torque to a tooth surface, if inner parts having differently angled sockets are prepared, a desired torque can be applied only by selecting the appropriate inner part without changing the bracket. Therefore, the wire can be attached in a relatively short time, and the treatment time can be reduced.

The handle part **52** is to facilitate handling of the inner part **50** and is coupled to the base part **51** by the joint part **53**. The handle part **52** is used when inserting the inner part **50** into the slot **30**. The handle part **52** has a width of about 8.0 mm and a length of about 7.0 mm. As described later, the handle part **52** is cut away and separated from the base part **51**.

Now, assembly of the bracket **10** and the inner part **50** will be described.

The wire **60** having a rectangular cross section is inserted into the slot **30**, and then, the inner part **50** is inserted into the slot **30**. Specifically, after the wire **60** is inserted into the slot **30** through an opening **32**, the inner part **50** and the slot **30** are placed side by side so that the arc-shaped outer perimeter of the inner part **50** and the arc-shaped inner surfaces (arc-shaped surfaces **12***a* and **13***a*) of the slot **30** are aligned with each other, and the opening **32** and the joint part **53** are aligned each other. Then, the inner part **50** is moved horizontally and inserted into the slot **30**. When the entire inner part **50** is housed in the slot **30** as shown in FIG. **6**, the handle part **52** is cut away. The inner part **50** from which the handle part **52** is removed is composed of the base part **51** and the joint part **53**, and as shown in FIG. **7**, the joint part **53** is positioned in the opening **32** of the slot **30** to close the opening **32**. At this time, the inner part **50** (joint part **53**) is held between a surface **12***b* of the upper arm portion **12** and a surface **13***b* of the lower arm portion **13** and therefore is prevented from rotating (moving) vertically, and a torque is applied to the teeth in this state.

The handle part **52** has a width of about 8.0 mm and a length of about 7.0 mm. The dimensions of the wire **60** are appropriately selected. For example, a rectangular wire having a height of 0.016 mm and a width of 0.022 mm, a height of 0.018 mm and a width of 0.025 mm, a height of 0.021 mm and a width of 0.025 mm, or a height of 0.017 mm and a width of 0.027 mm is used.

In summary then, the invention described above discloses an orthodontic device consisting of two parts: (a) a bracket, and (b) an inner part. The bracket is bonded to a tooth of a patient. The inner part is movable and removable and is placed in the slot of the bracket. The socket in the inner part is shaped to hold an orthodontic wire and apply desired forces to the wire for orthodontic treatment of a patient. When forces applied to the wire need to be changed during the treatment of a patient the inner part can be replaced with a different suitable inner part without replacing the bonded bracket. This is a major advantage of the orthodontic device disclosed herein over the standard bracket which requires debonding of the

current bracket and bonding of the new bracket. Furthermore, the inner part disclosed herein can be positioned to hold the wire in place.

We claim:

1. An orthodontic device, comprising:

a bracket and an inner part;

wherein said bracket comprises a base portion having a back surface designed for bonding said bracket to a tooth surface during orthodontic treatment of a patient, an upper arm portion extending forward from a front surface of said base portion, and a lower arm portion extending forward from said front surface of said base portion; wherein an arc-shaped surface of said upper arm portion and an arc-shaped surface of said lower arm portion facing each other form a slot on said front surface;

wherein said inner part has a base part, a handle part, and a joint part connecting an outer perimeter of said base part on one end and said handle part on an opposing end;

wherein said handle part has a recess, said recess being formed to engage a protrusion part disposed on a back surface of said lower arm portion;

wherein said inner part is designed to be inserted into said slot and has a socket; said socket shaped to hold a wire and exert desired forces to said wire during orthodontic treatment of said patient;

wherein said upper arm portion has a shape of a hook, and tip part of said upper arm portion is curved to cover an outer perimeter of said inner part;

wherein said lower arm portion has a shape of a hook, and tip part of said lower arm portion is curved to cover said outer perimeter of said inner part;

wherein said inner part is inserted in said slot, and said inner part is held stably between said arc-shaped surface of said upper arm portion and said arc-shaped surface of said lower arm portion;

wherein said inner part can be removed and replaced with another inner part to realize different forces applied to said wire without having to remove said bracket bonded to said tooth.

2. The orthodontic device according to claim 1, wherein a horizontal width of said slot and a horizontal width of said inner part are substantially equal to each other.

3. The orthodontic device according to claim 1, wherein said base part has a part cutoff therein, thereby creating said socket with an opening in said base part.

4. The orthodontic device according to claim 1, wherein said joint part in combination with said base part closes said socket once said base part is entirely inserted into said slot, thereby reliably holding a wire inserted in said socket.

5. The orthodontic device according to claim 1, wherein said socket is shaped to conform to hold a rectangular shape wire.

6. The orthodontic device according to claim 1, wherein said socket is shaped to conform to hold a square shape wire.

7. The orthodontic device according to claim 1, wherein said socket is shaped to conform to hold a polygonal shape wire.

8. The orthodontic device according to claim 1, wherein said upper arm portion and said lower arm portion have a vertical slit with respect to said slot.

9. The orthodontic device according to claim 1, wherein said bracket and said inner part are made of a dental metal, a synthetic material, a ceramic, or a synthetic resin.

10. The orthodontic device according to claim 1, wherein said inner part is shaped to provide desired torque.

11. The orthodontic device according to claim 1, wherein said inner part is shaped to provide desired angulation.

12. The orthodontic device according to claim 1, wherein said inner part is shaped to provide desired rotation.

13. The orthodontic device according to claim 1, wherein said inner part is shaped to provide desired translation.

14. The orthodontic device according to claim 1, wherein said inner part is shaped to provide desired combination of two or more forces such as torque, angulation, rotation and translation.

15. An orthodontic device, comprising:

a bracket and an inner part;

wherein said bracket comprises a base portion having a back surface designed for bonding said bracket to a tooth surface during orthodontic treatment of a patient, an upper arm portion extending forward from a front surface of said base portion, and a lower arm portion extending forward from said front surface of said base portion; wherein an arc-shaped surface of said upper arm portion and an arc-shaped surface of said lower arm portion facing each other form a slot on said front surface;

wherein said inner part has a base part, a handle part, and a joint part connecting an outer perimeter of said base part on one end and said handle part on an opposing end;

wherein said handle part facilitates easy insertion of said inner part into said slot;

wherein said inner part has a socket;

wherein said slot and said socket together reliably hold a wire into said bracket during said treatment;

wherein said socket has three surfaces specifically shaped to accommodate said wire;

wherein said socket is further shaped to apply desired forces to said wire during said treatment;

wherein said upper arm portion has a shape of a hook, and tip part of said upper arm portion is curved to cover an outer perimeter of said inner part;

wherein said lower arm portion has a shape of a hook, and tip part of said lower arm portion is curved to cover said outer perimeter of said inner part;

wherein said inner part is inserted in said slot and said inner part is held stably between arc-shaped surface of said upper arm portion and said arc-shaped surface of said lower arm portion; and

wherein said inner part can be removed and replaced with another inner part to realize different forces without having to remove said bracket bonded to said tooth.

16. The orthodontic device according to claim 15, wherein said handle part can be removed after said inner part is inserted into said slot.

17. The orthodontic device of claim 15, wherein said desired forces applied to said wire comprise torque.

18. The orthodontic device of claim 15, wherein said bracket and said inner part are made of either a dental metal, or a synthetic material, or a ceramic or a synthetic resin.

19. The orthodontic device of claim 18, wherein said synthetic resin is either polymethyl methacrylate, or polyoxymethylene, or polycarbonate, or polypropylene, or polyethylene or polyethylene naphthalate.

20. The orthodontic device according to claim 15, wherein said socket is shaped to hold a rectangular wire; and wherein said socket is angled relative to an axis line perpendicular to bottom surface of said socket.

21. The orthodontic device of claim 15, wherein said socket is shaped to hold a wire having a circular cross section.

22. The orthodontic device of claim 15, wherein said socket is shaped to hold a wire having a rectangular cross section.

23. The orthodontic device of claim 15, wherein said socket is shaped to hold a wire having a polygonal cross section.

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